

# Interactive Projector Screen with Hand Detection Using LED Lights

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## Abstract

There are many different ways to manipulate OS, we can use a keyboard, mouse or touch screen. While doing a presentation, it is inconvenient to control the OS and explain the presentation at the same time. Our system, interactive wall, allows you to use hand to control OS on the projection screen which will act as touch screen. You can now experience a novel approach to control your cursor. Our system can be applied to the existing equipment, so you don't need to purchase any expensive touch screen. The system requires one web camera to detect the hand and then you can start to experience our system. Also, three LED lights are required to put on the fingers to help the system to detect the location of the hand and the gesture performing.

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## 1. INTRODUCTION

### 1.1 Overview

The goal of this project is to build an interactive wall display for presentation or classroom use. The physical equipment required is not restricted. Any size of projection screen can be set up for the system or you can use a wall or a table to project the screen. User can be more flexible to enjoy our interactive wall at any place. Human Computer Interaction in the field of input and output techniques has developed a lot of new techniques over the last few years. With the recently released full multi-touch tablets and notebooks the way how people interact with the computer is coming to a new dimension. As humans are used to handle things with their hands the technology of multi-touch displays or touchpad's has brought much more convenience for use in daily life. The usage of human speech recognition will play an important part in the future of human computer interaction. This project introduces techniques and devices using the humans

hand gestures for the use with multi-touch tablets and video recognition and techniques for interaction. Thereby the gesture recognition take an important role as these are the main communication methods between humans and how they could disrupt the keyboard or mouse as we know it today.[10]

## 1.2 Motivation

- The size of touch-screens is usually quite small and limited.
- Expenses are directly proportional to size.
- Furthermore, some control methods are not very user-friendly.
- SOLUTION: using cameras to allow the same kind of user input as touch-screens do, but with a lower price and a larger screen.
- Hence AIM: to design a web camera-based system to perform like an interactive screen but with a larger sized screen and using our own hands to control it. [2]

## 2. METHODOLOGY

### 2.1 INPUT

Input includes valid region detection, hand shape recognition and gesture detection. Our system first implements valid region detection to achieve the display screen resolution and it identifies the x-y coordinates in the captured image on the screen. Then it recognizes the hand's shape and location and passes the x-y coordinates to the interface/output part of the system. Since the user may use different hand gestures to control the virtual mouse, the system detects and interprets specific hand gestures and passes the respective command(s) to the interface.

### 2.2 INTERFACE/OUTPUT

The interface is the device that can communicate between the recognition part and the OS. After the input part passes the data to the interface, the interface performs the action immediately and produces associated output. The system design follows the general architecture's five main components which are required to form the interactive Wall. The Prototyping Software Development Process design was used to test and refine the hand recognition algorithm until it achieved optimal performance for building a well-structured and robust system.

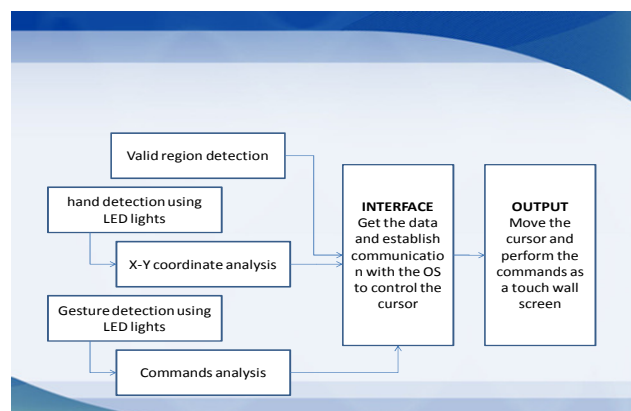


FIGURE 1: General architecture design

## 2.3 IMPLEMENTATION

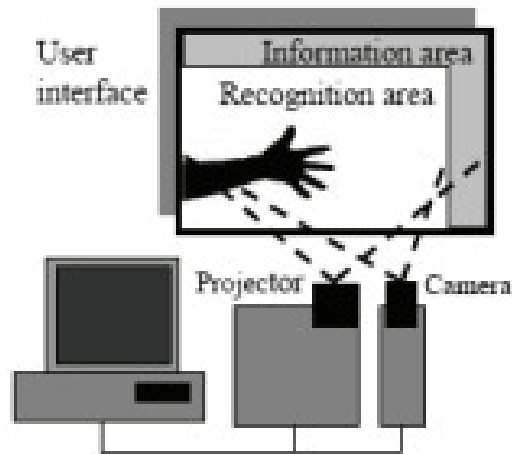


FIGURE 2: System Overview

### 2.3.1 VALID REGION DETECTION

For the system to be interactive, it requires real time processing and also synchronization with human hand gestures. In order to do this, we carefully identify the projected area for accurate positioning of the cursor in the design phase. If the hand is out of the projected area, then all the gestures or commands are invalid. The system only executes the commands when the hand is inside the projected area. Since the projected area must be a rectangle, we decided to use this characteristic to identify the area. By using the contour finding function (i.e. `cvFindContours`) from OpenCV, it was easy to find out four end points (i.e. the 4 corners of the projected area) of a contour. But this method failed as it may be possible that laptop, hence camera is at some angle to the screen, which caused incorrect mapping of x-y coordinates to the mouse cursor. So we decided to implement a function which allows the user himself to crop the image shown in the camera input to show up only the valid region (projector screen).[7]

### 2.3.2 HAND DETECTION

[1]LED lights provide a stable and efficient way to locate the position of the hand. The system only requires three LED lights because this number of lights provides sufficient commands and no interference affects the control.

Noise Filtering

1. Set the level of threshold to filter all the light of less intensity.
2. Cover the camera (either integrated or external) lens with a black film negative (photo reel film used in old cameras). This was the best method which let the system see only the bright white LED light.[9]

The current implementation tracks the brightest point in the current frame and show it encircled by a green colored pen appended with the x, y coordinates. This point was considered as centre (F). This gesture sends the `MOUSE_MOVE` command. If a second light is detected to the left of it (L) highlighted with a blue colored pen then a left click is generated and if a second LED light shows up on the right side (R) of (F), (highlighted with red color) then a right click is generated.

Both L and R are considered valid gestures only if they appear within region of interest (currently set by us as +-20 as radius).

### 2.3.3 GESTURE DETECTION

[3]After the hand detection, a maximum of three light sources can be detected: (i) the light that is closest to the track point is the first light F; (ii) the second light at the left hand side of F is L; (iii) the third light at the right hand side of F is R. We can imagine that F is the center of a circle with a certain radius. L and R will appear inside circle and be regarded as valid gesture commands.

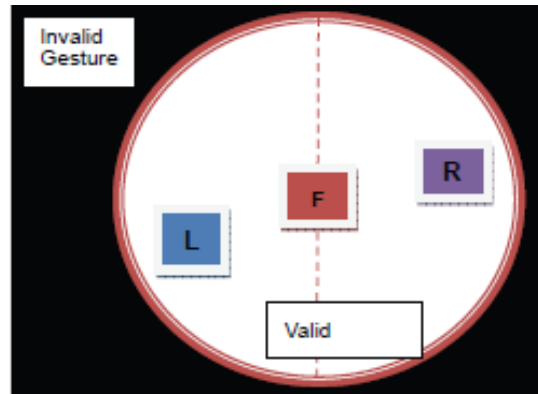


FIGURE 3: Gesture detection

The system relies on F, L and R to determine the actions. When only light F appears, the cursor synchronizes the position of the light on the projection screen. When light L appears on the left hand side of light F, then left click is executed. When light R appears on the right hand side of light F, then right click is executed. If three lights appear for a second, then the function of scrolling is executed. Since L and R can appear on any left part and right part in the circle respectively, it is difficult to keep tracks of L and R. Only F can be kept track of and used as the input method. The system analyzes the direction of movement of the track point and compares it with the pre-define pattern. If the input and the pattern match, then the corresponding command will be activated.

## 3. IMPLEMENTATION RESULTS

1. **Cursor movement** (with single LED detection): LED light on Index finger is detected by the camera as the centre point F. It takes this as the X-Y coordinate on the screen and maps the mouse cursor at this point.



Figure 4: Mouse Cursor tracking with single LED

2. **Right Click Implementation** (with LED detection to the right side of the index finger LED previously detected): LED light on Index finger is detected by the camera as the centre point F. Then another LED on the right side of F is detected as R. It takes F as the X-Y coordinate on the screen and implements right click at this point.

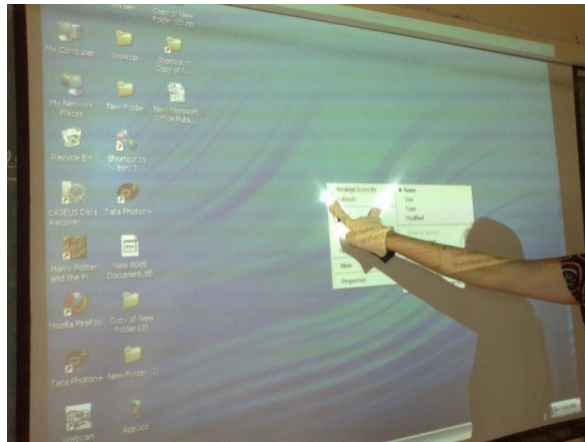


Figure 5: Right Click Implementation

3. **Left Click Implementation** (with an LED detection to the left side of the index finger LED previously detected): LED light on Index finger is detected by the camera as the centre point F. Then another LED on the left side of F is detected as L. It takes F as the X-Y coordinate on the screen and implements left click at this point.

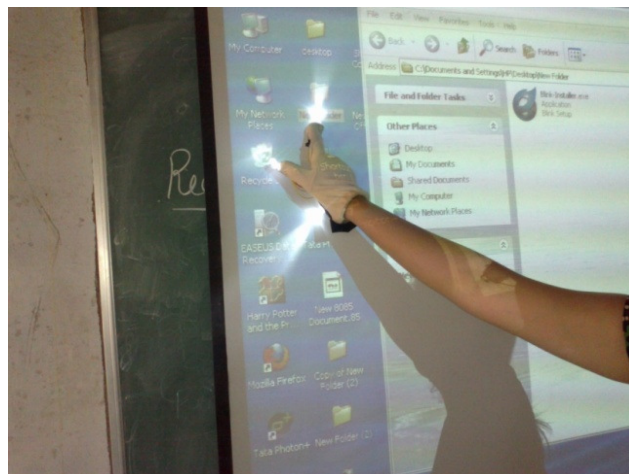


Figure 6: Left Click Implementation

## 4. CONCLUSION

1. Our system, Interactive Projector Screen, allows user to use LED hand glove to control OS on the projection screen but not touch screen.
2. The system requires one web camera to detect the LED light and then you can start to experience our system.
3. Also, three LED lights are required and sufficient to put on the fingers to help the system to detect the location of the hand and to perform mouse functions.
4. Any size of projection screen can be set up for the system or you can use a wall or a table to project the screen. User can be more flexible to enjoy our interactive wall in any places.

End Deliverable would be

1. A webcam with a particular resolution and other specifications with its lens covered with a black film negative to filter all the noise and light entering into the classroom to enable very smooth and stable functionality.
2. A Hand Glove with LED system integrated. This covers three 1Volt LED lights connected in parallel with a 9 volt battery. The battery lifetime is around 20 days if kept switched on continuously. The system also consists of 1pos On-Off switch which I used for simultaneous control of all 3 LED lights.

## 5. FUTURE SCOPE

1. Use with higher efficiency without preliminary training of gestures.
2. Interactive training of gestures to avoid retraining if an untrained user would like to use the system
3. To increase the number of gestures.
4. **Voice integration**
  - a. Speech Detection is always mentioned as the most common straight-forwarded way, after the gestural motion, of how people interact between each other. This fact of course impacts also the design of human computer interfaces. Within the section of speech detection the main point is of course the software. For speech recognition itself you only need a normal microphone. The only thing you then have to consider is noise which will be also recorded with your actual planed voice. The major thing thereby is to create a good algorithm not only to select the noise from the actual voice but rather detecting what humans are actually saying.
5. **Gaming**
  - a. The further implementation can be towards implementing features of gaming apart from the class room teaching and presentation applications , wherein gesture controls are able to manipulate the game operating system.[4]
6. **Key board implementation**
  - a. Many softwares exist which allow to open up a virtual keyboard. By installing any such software and projecting it as well on the screen can allow us implement all keyboard functionality same as provided by Sixth Sense Device of Pranav Mistry.[2]

## 6. REFERENCES

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